IN THE SPECIFICATION

Amend paragraphs 4, 9, 13, 68, 69, 71, 88, 98, 120, 127, 129, 133, and 152 - 154 as follows:

[0004] Light-emitting device 22 contains faceplate 32 coupled to backplate 24 of electron-emitting device 20 through an outer wall (not shown) to form a sealed enclosure maintained at a high vacuum. Light-emissive regions 34 overlie faceplate 32 respectively opposite electron-emissive regions 26. When electrons emitted by regions 26 strike light-emissive regions 34, the light emitted by regions 34 produces the display's image on the exterior surface (lower surface in Fig. 1) of light-emitting device 22. Contrast-enhancing black matrix 36 laterally surrounds light-emissive regions 34.

[0009] A ~~One~~ coating 44 fully surrounds each phosphor particle 42 in the example of Fig. 2. Coatings 44 can alter the surface chemistry of particles 42 in such a way that they are more thermodynamically resistant to outgassing. Alternatively, coatings 44 can simply be impervious encapsulants that substantially prevent any contaminant gases produced by particles 42 from entering the display's interior. In either case, coatings 44 are provided on particles 42 before they are deposited over substrate 40. The display's anode is formed with aluminum layer 46 provided above composite particles 42/44.

[0013] The light-emissive particles in the light-emissive region of the present light-emitting device are provided with coatings that perform various functions. In some cases, the particle coatings enable the intensity of light that travels generally in the forward direction to be enhanced, especially when the light-emitting device contains a light-reflective layer situated over the coatings. Alternatively or additionally, the particle coatings may cause the optical contrast to be enhanced between two such light-emissive regions when one of the light-emissive regions is turned on (emitting light) and the other is turned off (not emitting light). The coatings may getter contaminant gases. The coatings also typically reduce damaging effects that occur as the result of electrons striking the light-emissive particles.

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[0068] In the exemplary display of Figs. 4 and 5, black matrix 68 ~~58~~ is thicker (or taller) than light-emissive regions 66 and preferably includes electrically insulating material that contacts light-reflective layer 70. As described further below, electrons emitted by electron-emissive regions 58 in electron-emitting device 50 pass through layer 70 and strike light-emissive regions 66, causing them to emit light in all directions. Some of the electrons which

strike regions 66 ~~56~~ are scattered backward off regions 66 rather than causing regions 66 to emit light. Black matrix 68 collects some of these backscattered electrons and thereby prevents the so-collected electrons from striking non-intended ones of regions 66 and causing image degradation. By having matrix 68 extend vertically beyond regions 66, the ability of matrix 68 to collect backscattered electrons is enhanced.

[0069] Alternatively, black matrix 68 can be thinner (shorter) than light-emissive regions ~~region~~ 66. In that case, black matrix 68 preferably includes electrically conductive material that contacts light-reflective layer 70.

[0071] Returning to light-emissive regions 66, each region 66 consists of multiple light-emissive phosphor particles 72 distributed generally randomly over the portion of faceplate 64 below that region 66. The average thickness of light-emissive regions 66 is typically greater than a monolayer (a one-particle-thick layer of particles packed as closely together as possible), e.g., 1.5 monolayers, and up to 3 monolayers or more, but can be less than a monolayer. Phosphor particles 72 are roughly spherical in shape and vary somewhat in diameter from one to another. As used here, the diameter of a particle 72 is the diameter of a perfect sphere which occupies the same volume as that particle 72. The mean diameter of particles 72 is 1 - 15 μm, typically 5 μm. At the typical mean diameter of 5 μm, the coefficient of quartile deviation in the mean particle diameter is typically 0.2 - 0.3.

[0088] Light-reflective coatings 74 function as getter coatings when they consist of certain of the preceding thirty-two metals and metal oxides. Getter candidates for this purpose include the metals magnesium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zirconium, niobium, molybdenum, palladium, silver, barium, tantalum, tungsten, platinum, lead, and thorium, including alloys of one or more of these twenty metals. Coatings 74 can then sorb contaminant gases, including gases released by phosphor particles 72 upon being struck by electrons as well as gases otherwise present in the interior of the flat-panel display. Magnesium, chromium, manganese, iron, cobalt, nickel, copper, molybdenum, palladium, silver, platinum, and lead, are particularly suitable for sorbing sulfur, especially sulfur released by particles 72 when they are metal sulfide phosphors (again including metal oxysulfide phosphors). In one embodiment, coatings 74 consist largely of palladium or/and chromium.

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[0098] Depending on the configuration of the overall flat-panel display, electromagnetic wave energy can be directed locally toward coatings 74 to activate the getter material. For example, the getter material can sometimes be activated with a beam of directed energy such as a laser beam. In some cases, the activation can be accomplished by directing radio-frequency energy, such as microwave energy, toward the getter material. Electrons emitted by electron-emissive regions 58 ~~48~~ in electron-emitting device 50 pass through, and thereby strike, coatings 74. These electrons are of relatively high energy and, in certain cases, can activate the getter material.

[0120] As in light-emitting device 52, each light-emissive region 66 of light-emitting device 80 consists of multiple light-emissive phosphor particles 72 distributed generally randomly over the portion of faceplate 64 below that region 66. The ~~However, the~~ average thickness of regions 66 in device 80 is illustrated as being significantly less than a monolayer. That is, adjacent particles 72 in each region 66 of device 80 in Fig. 7 often do not touch one another. Consequently, particles 72 in each region 66 are not packed as closely together as possible. This less-than-maximum density packing would arise even if particles 72 were perfect spheres of the same diameter.

[0127] Light-reflective layer 70 overlies intensity-enhancement coatings 82 and 84 and typically conformally contacts some or all of second coatings 84. Similar to how layer 70 conforms, on the average, to only part of each light-reflective coating 74 in light-emitting device 52 of Figs. 4 and 5, coatings 82 and 84 in light-emitting device 80 of Fig. 7 normally extend sufficiently far down phosphor particles 72 toward faceplate 64 that layer 70 conforms, on the average, to only part of the upper surface of each coating 84.

[0129] A layer (not shown) of the material that forms first intensity-enhancement coatings 82 may be situated on black matrix 68. A layer (not shown) of the material that forms second intensity-enhancement coatings 84 may similarly be situated over matrix 68, either directly on matrix 68 or on ~~or, when present, over~~ the layer of first intensity-enhancement material when it is present on matrix 68. The presence of either or both of these layers of intensity-enhancement material is typically not harmful and can sometimes be beneficial. When matrix 68 contains material, e.g., polymeric material such as polyimide, which emits contaminant gases when struck by electrons, the intensity-enhancement material overlying matrix 68 can be utilized as a shield to reduce the amount of these gases that enter the interior

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of the display. Also, this intensity-enhancement material is substantially transparent and thus does not significantly affect the light-absorption function performed by matrix 68.

[0133] The outer surface of light-reflective layer 70 forms the interior surface of light-emitting device 80 and thus is subjected to the high vacuum in the interior of the flat-panel display. As mentioned above, layer 70 is normally perforated. Due to the perforation of layer 70 or/and the way in which device 80 is fabricated, ~~fabricated~~ at least part of the outer surface of each second coating 84 is subjected to the high vacuum in the display's interior where refractive index n_I is approximately 1. Each phosphor particle 72 and overlying intensity-enhancement coatings 82 and 84 therefore provide a structure in which the average refractive index starts at n_P, typically greater than 2, for that particle 72 and then drops progressively in going through overlying coatings 82 and 84 down to approximately 1 in the substantial vacuum along at least part of the outer surface of overlying second coating 84.

[0152] For the purpose of determining the conditions which result in approximately the maximum amount of rear-directed light escaping phosphor particles 72 and the m coatings overlying each particle 72, let r_P again represent ratio n_P/n_1. Let r_i represent the ratio n_i/n_{i+1} where i is an integer varying from 1 to m-1, n_i is the average refractive index of the ith coating, and n_{i+1} ~~nm~~ is the average refractive index of the (i+1)th ~~mth~~ coating. Furthermore, let r_m represent the ratio n_m/n_I where n_m is the average refractive index of the mth coating. ~~nm/n$_I$.~~ Utilizing relationship 1 or 2 given above, ignoring any light absorption in the m coatings overlying each particle 72, and ignoring secondary reflections in those m coatings, the maximum amount of rear-directed light escapes particles 72 and the m coatings overlying each particle 72 when each of ratios r_p, r_1, r_2, . . . r_m is of value r_{OPT} given as: ~~as :~~

$$r_{OPT} = \left(\frac{n_P}{n_I}\right)^{1/(m+1)} \qquad (6)$$

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Eq. 6 reduces to Eq. 3 for the specific example of Fig. 7 in which m is 2.

[0153] For the condition prescribed by Eq. 6, the optimum value n_{iOPT} of refractive index n_i is:

$$n_{iopt} = n_p^{(m+1-i)/(m+1)} n_I^{i/(m+1)} \approx n_P^{(m+1-i)/(m+1)} \qquad (7)$$

where i here varies from 1 to m and where the approximation utilizes the fact that high-vacuum refractive index n_l is approximately 1. Eq. 7 reduces to Eqs. 4 and 5 when m is 2. Refractive indices n_1 - n_m ~~n_1 — n_m~~ are preferably chosen to approach their optimum values, such as those prescribed by Eq. 7, as closely as possible.

[0154] In addition, let Δn_p again represent refractive-index difference $n_p - n_l$. Let Δn_i represent the refractive-index difference $n_i - n_{i+1}$ for i varying from 1 to m-1. Let Δn_m represent the refractive-index difference $n_m - n_l$. ~~$n_m - n_l$.~~ When ratios r_p and $r_l - r_m$ are at their optimum values given by Eq. 7, refractive-index differences Δn_p and $\Delta n_l - \Delta n_m$ progressively decrease so that difference Δn_p is the largest and difference Δn_m is the smallest.

Delete the revision made to paragraph 164 via the Amendment submitted 27 March 2002 and, in place of that revision, amend paragraph 164 as follows:

[0164] In conjunction with having reduced chemical reactivity compared to the native aluminum oxide layer, layer 102 has a lower gas-sticking coefficient than the native oxide layer. Consequently, the likelihood of contaminant gases adhering to the interior surface of the active portion of light-emitting device 80 is reduced compared to what would occur if the interior surface of the active portion were formed with the native aluminum oxide layer. Further details on layers such as additional layer 102 are presented in Cummings et al, co-filed U.S. patent application 09/823,872, now U.S. Patent 6,630,786 B2. ~~attorney docket No. CT-F137-US.~~

Amend paragraphs 169, 187, 188, 198, 214, 218, 223, 224, 235, 242, and 252 as follows:

[0169] Subject to any differences that may arise because the material of light-reflective coatings 74 in light-emissive device 52 fabricated according to the process of Fig. 6 differs from the first intensity-enhancement material, first intensity-enhancement coatings 82 are typically formed in a high-vacuum environment according to any of the techniques utilized for creating coatings 74 in the process of Fig. 6. These techniques include sputtering, evaporation, thermal spraying, and electrophoretic/dielectrophoretic ~~electrophoretic/dielectrophoretic~~ deposition. The same applies to deposition of the second intensity-

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enhancement material for creating second coatings 84. Coatings 82 and 84 can also be formed by CVD or sol gel deposition.

[0187] Fig. 11 illustrates a side cross section of part of the active region of a flat-panel CRT display having electron-emitting device 50, again configured as described above, and an oppositely situated light-emitting device 110 configured according to the invention for enhancing the image intensity and ~~or/and~~ the optical contrast of the display. Devices 50 and 110 connected together through an outer wall (not shown) to form a sealed enclosure maintained at a high vacuum, once again typically an internal pressure of no more than 10-6 torr. As viewed along a plane extending laterally through the sealed enclosure, the active portion of light-emitting device 110 has a plan view largely identical to that of Fig. 5. The display of Fig. 11 typically includes spacers, again represented by exemplary spacer wall 54 in Fig. 5, situated between devices 50 and 110, and may have getter material located at various places in the display.

[0188] Light-emitting device 110 contains components 64, 66, 68, and 70 configured, constituted, and functioning the same as in light-emitting device 80 of Fig. 7. Each light-emissive region 66 is thereby formed with generally randomly located light-emissive phosphor particles 72. Although the thickness of regions 66 is, for example, illustrated as being less than a monolayer in device 110 ~~10~~ of Fig. 11, the thickness of regions 66 can as well be greater than a monolayer, again typically 1.5 monolayers and up to 3 monolayers or more. Black matrix 68 is again depicted as being thicker than regions 66 but can be thinner than regions 66.

[0198] A layer (not shown) of the intensity-enhancement material may be situated on black matrix 68. A layer (not shown) of the contrast-enhancement material may similarly be situated over matrix 68, either directly on matrix 68 or ~~or, when present,~~ on the layer of intensity-enhancement material when it is present. The presence of the layer of intensity-enhancement material or/and the layer of contrast-enhancement material is typically not harmful and can sometimes be beneficial. When matrix 68 contains material that emits contaminant gases upon being struck by electrons, either or both these layers can serve as a shield to reduce the amount of these gases that enter the display's interior. The layer of contrast-enhancement material can also enhance the light-absorption function of underlying matrix 68.

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[0214] Contrast-enhancement coatings 114 are subsequently formed by providing the desired contrast-enhancement material on intensity-enhancement coatings 112 so that contrast-enhancement coatings 114 are spaced apart from where phosphor particles 72 are closest to faceplate 64. See Fig. 13d. ~~13e.~~ Subject to any differences that may arise because the material of light-reflective coatings 74 in light-emitting device 52 differs from the contrast-enhancement material, coatings 114 are typically formed in a high-vacuum environment according to any of the techniques utilized for creating coatings 74 in the process of Fig. 6.

[0218] Light-reflective layer 70 is formed over black matrix 68 and contrast-enhancement coatings 114 in generally the same way that layer 70 is formed over matrix 68 and light-reflective coatings 74 in the process of Fig. 6. See Fig. 13e. ~~13d.~~ In particular, intermediate layers (not shown) of generally solid material, typically dried lacquer, which can readily be converted to gas are formed in the black-matrix openings so as to just cover, or nearly cover, coatings 114 and 112 and phosphor particles 72 in those openings. Any of the techniques used in the process of Fig. 6 to prevent lacquer from accumulating on top of matrix 68, or on any material on top of matrix 68, can be utilized for the same purpose here. After depositing layer 70, the structure is heating to remove the intermediate layers by converting them to gases which escape through the perforations in layer 70. The structure of Fig. 13e ~~13d~~ is light-emitting device 110 of Fig. 11.

[0223] Fig. 15 illustrates a side cross section of part of the active portion of a light-emitting device 128 configured according to the invention for enhancing image intensity and ~~or/and~~ optical contrast. Light-emitting device 128 is basically an extension of light-emitting device 110 of Fig. 11 and thus is substitutable for device 110 in the flat-panel CRT display of Fig. 11. ~~Fig. 7.~~ Except as described below, device 128 contains components 64, 66, 68, 70, 72, and 114 constituted, configured, and functioning the same as in device 110 of Fig. 11. ~~Fig. 7.~~ Accordingly, each contrast-enhancement coating 114 normally consists of multiple portions spaced apart from each other.

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[0224] In place of intensity-enhancement coatings 112, light-emitting device 128 contains first intensity-enhancement coatings 82 and second intensity-enhancement coatings 84 configured and constituted the same as in light-emitting device 80 of Fig. 7. Hence, each pair of associated intensity-enhancement coatings 82 and 84 covers part of the outer surface

of one phosphor particle 72. Contrast-enhancement coatings 114 are respectively situated on second intensity-enhancement coatings 84 here in the same way that coatings 114 are situated on intensity-enhancement coatings 112 in light-emitting device 110 of Fig. 11. Accordingly, each contrast-enhancement coating 114 covers only part of associated second intensity-enhancement coating 84. The average refractive index thereby progressively decreases in going from each particle 72 ~~74~~ through overlying intensity-enhancement coatings 82 and 84 to the high vacuum along part(s) of the outer surface of that second intensity-enhancement coating 84.

[0235] A layer (not shown) of the intensity-enhancement material may be situated on black matrix 68 in light-emitting device 130. A layer (not shown) of the light-reflective material that forms coatings 74 may similarly be situated over matrix 68, either directly on matrix 68 or ~~or, when present,~~ on the layer of intensity-enhancement material when it is present. The presence of the layer of intensity-enhancement material or/and this additional layer of light-reflective material is typically not harmful and can be beneficial. Should matrix 68 emit contaminant gases upon being struck by electrons, either or both of these layers can act as a shield to reduce the amount of these gases that enter that display's interior. If the additional light-reflective layer consists of metal, the additional light-reflective layer can assist in removing electronic charge from phosphor particles 72 when they are struck by electrons. The additional light-reflective layer may also cooperate with light-reflective layer 70 in functioning as the display's anode.

[0242] Light-emitting device 130 can be modified in various ways. Each intensity-enhancement coating ~~coatings~~ 112 can be replaced with two or more intensity-enhancement coatings of progressively decreasing average refractive index in moving away from underlying phosphor particle 72. In general, part of the outer surface of each particle 72 can be covered with m intensity-enhancement coatings having the properties, including progressively decreasing average refractive index, described above for the modifications of light-emitting devices 80 and 110. Light-reflective coatings 74 are situated on the mth intensity-enhancement coatings.

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[0252] When the thickness of each light-emissive region 66 is greater than a monolayer, e.g., from 1.5 monolayers up to 3 monolayers or more, contrast-enhancement coatings ~~coating~~ 114 can sometimes be deleted in light-emitting device 110 of Fig. 11. Light-

reflective layer 70 then lies directly on intensity-enhancement coatings 112. In the implementation of device 110 in Fig. 12, layer 120 of the contrast-enhancement material is also deleted along with any pieces of the contrast-enhancement material situated on pieces 116 of the intensity-enhancement material or, if pieces 116 are absent, situated on protective layer 90 in the spaces between phosphor particles 72 of each region 66. The fabrication of such a variation of device 110 is performed in the manner described above except that the deposition of the contrast-enhancement material is deleted from the fabrication process. Device 110 can also sometimes be modified to delete contrast-enhancement coatings 114 when the thickness of each region 66 is significantly less than a monolayer.

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